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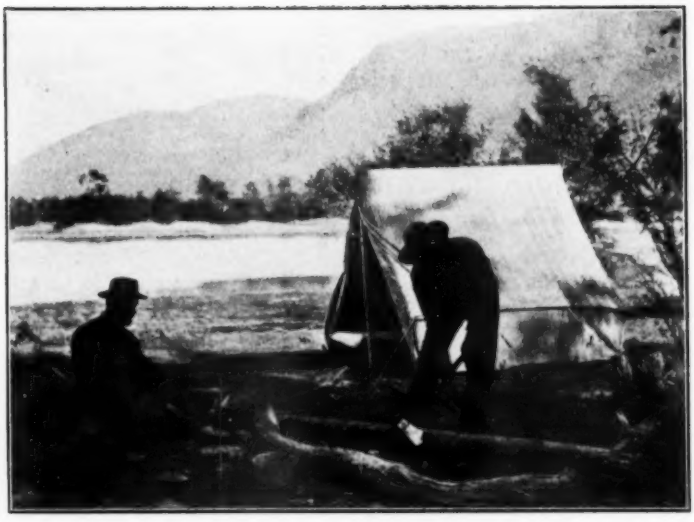
PLATE XIII



Dr. Deville (left of picture) in camp, 1881, when Inspector of Surveys

PLATE XII

Dr. Deville's Birthplace, Grande Rue, La Charite, France
(House in centre, directly behind the boy)

PLATE XI

Dr. Edouard Gaston Deville, 1849-1924

THE JOURNAL
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OF CANADA

VOL. XVIII DECEMBER No. 10

DR. EDOUARD GASTON DEVILLE

DIRECTOR GENERAL OF SURVEYS, DEPARTMENT OF THE INTERIOR, OTTAWA

By J. D. CRAIG

Another of Canada's big men has passed on to his well-earned rest and reward, and in the death, on September 21st last, of Dr. Edouard Gaston Deville, I.S.O., D.T.S., Canadian science, in fact science in general, the Canadian Government, and the City of Ottawa suffered a loss, the extent of which will be fully revealed only as time passes.

He was an indefatigable worker in the subjects in which he was interested and he rarely missed a day from his office, one might say an hour, except on official business elsewhere, from the time of his appointment to the Federal Government Service in 1881 until he was stricken in April last with the illness which proved to be his last.

Modest and unostentatious in the performance of his duties, he was possibly little known to the average citizen of Ottawa, although he gave freely of his time and knowledge for the benefit of the community and his services for years in connection with hospital work, and with St. Luke's Hospital in particular, need only be known to be appreciated. As a member also of the Board of the new Civic Hospital, his loss will be greatly felt, for

"old timers", some of whom were accustomed to making their surveys by rather slip-shod methods. It was not long, however, before they began to see the light and fell into line, and it is admitted freely to-day that the system as developed by Dr. Deville is second to none for its particular purpose.

All old time engineers are familiar with the old elongation method at night with all its vexatious troubles and the time consumed in taking observations. By having transit theodolites designed with high class telescopes with large objectives, and the introduction of field tables by means of which the azimuth of the Pole Star at any time could be taken out by inspection from these tables, Dr. Deville made it possible for observations to be taken at any time of the day provided the sky was clear. As a consequence the surveyors soon got into the habit of taking observations two and three times a day in the course of their work. A tremendous improvement in the accuracy of the surveys naturally followed.

Other evidences of his effective interest in details connected with his work as the completeness of the equipment of the photographic, lithographic and printing sections of the Branch of which he was for so many years the direct and responsible head, and the efficiency with which these sections continue to turn out large quantities of excellent work.

The Topographical Surveys Branch of the Department of the Interior was for years unable to live fully up to its name, all, or almost all, of its energies being directed to the great task of keeping the subdivision of land ahead of the phenomenal development of Western Canada—surveys had to be kept ahead of settlement, and with thousands of settlers pouring into the country monthly, this was no mean task.

Dr. Deville was early impressed with the importance of developing a feasible system of topographic surveying for the mountainous portions of the far west, a system which would insure accuracy at a reasonable cost. His investigational work in this connection, along photographic lines, assisted in the field by various colleagues in the department, notably Messrs. J. J. McArthur, D.L.S., and W. S. Drewry, D.L.S., resulted in the development of photographic surveying into the science which it is to-day.

He was a recognized pioneer in this work and his book, *Photographic Surveying*, published in 1895, is still recognized by experts as a standard text-book on the subject. It is worthy of note that, in the recent Mount Everest expedition, photographic surveys were made with a camera copied largely from those designed by Dr. Deville for use on Canadian surveys. Photography was one of his great hobbies both from the optical or scientific side and from the artistic. He knew his camera in every sense of the word, and his collection of photographs taken in various parts of the world is equalled by few. He was the author also of another authoritative text-book, *Astronomic and Geodetic Calculations*, and contributed many papers to various societies on matters of popular and scientific interest.

Quite typical of his interest in the details of any subject were his persistent efforts for years to improve the permanent marks used on land surveys. He considered the marks left by a surveyor of even greater importance than the actual survey work itself, in fact in a paper read before the Ontario Land Surveyors' Association in 1920 he stated that "the most important feature of a land survey is the boundary monuments." The iron monuments used at present on Dominion Land surveys are the result of years of continued effort on Dr. Deville's part, and for permanency, legibility, economy in cost and ease of transportation can hardly be improved upon.

Dr. Deville always displayed an active interest in the affairs of the Dominion Land Surveyor's Association and was identified with that organization from the time when it first came into being in the early eighties.

During the first tenure of the Association's life, Dr. Deville was an honorary member along with a few others prominent at that time in the profession. Upon his elevation to the position of Surveyor General of Dominion Lands in 1885 he became its Honorary President. When the Association was again organized, about fifteen years ago, he became its Patron. This office he held at the time of his death. He was also a charter member of the Royal Society of Canada and was for over twenty years Secretary of the Scientific Section.

As an evidence of his many other interests it should be noted

that he had been a Governor of St. Luke's Hospital, Ottawa, from its inauguration in 1898, and in addition was a Governor of L'Alliance Française, Chairman of the Board of Topographic Surveys and Maps, Chairman of the Board of Examiners for Dominion Land Surveyors, Chairman of the Geographic Board of Canada, member of the Canadian Engineering Standards Association, member of the Air Board of Canada, Patron of the Town Planning Institute of Canada and of the Dominion Land Surveyor's Association and until a week before his death a member of the Board of the new Civic Hospital.

The University of Toronto in 1905 paid a tribute to his services in the cause of science when they conferred upon him the honorary degree of Doctor of Laws, while in 1916 His Majesty the King rewarded his faithful work by appointing him a Companion of the Imperial Service Order, as a recognition of the sterling services he had rendered to Canada and to the Empire. Two years ago he was further honoured by being appointed to represent Canada at the meetings of the International Union of Geodesy and Geophysics held at Rome, when no less than twenty allied countries were represented.

While the estimates of the Department of the Interior were under discussion in April, 1922, the Honourable Mr. Meighen, Leader of the Opposition, paid Dr. Deville the following notable tribute: "Not only is Dr. Deville a competent official but I think he is one of the very few examples—if not the only one—where the undoubted and admitted head of his profession in this Dominion is, in so far as his profession is concerned, at the head of the service. I do not think there is any one in the Dominion who compares with Dr. Deville in his own profession, and it is fortunate we have him in our employ."

Another rare but well-deserved tribute was paid to Dr. Deville at Montreal on the evening of the 24th October, 1922, when the Council of the Engineering Institute of Canada elected him to honorary membership in the Institute. The nature of this honour is the better appreciated when it is realized that, previous to Dr. Deville's election, there were only ten such honorary members living, and that this select number included H.R.H. the Prince of Wales, H.R.H. the Duke of Connaught, Duke of Devonshire, Earl

of Aberdeen, Baron Byng of Vimy, Lord Shaughnessy, and a few others prominent in the national life of the Dominion.

As a mark of esteem by the members of the Ottawa Branch on this occasion a complimentary luncheon was tendered to him at the Chateau Laurier at noon on October 31st, 1922, about one hundred and fifty being present.

The Chairman, in speaking of the esteem and honour in which Dr. Deville was held, stated that he had not only brought renown to the Ottawa Branch by his great work but had brought recognition to the engineering profession in Canada and had placed it on a par with the foremost in the world.

In presenting him on behalf of the Branch with the gold badge of membership, Mr. Thomas Shanks, his associate in his work for many years, made feeling reference to his outstanding qualities, saying in part: "I feel it would not be out of place to call attention to Dr. Deville's positive genius for certain phases of scientific work; to his unflagging industry; to his patient and humble devotion to duty; to his mastery of essential details as the executive head of a rather complex organization; to his power of concentration on the larger problems connected with his chosen life work; to the incorruptible integrity of his administration; to his honourable and fair dealing with subordinates and to his loyalty to superiors in office; to his scrupulous and painstaking research into every phase of any subject which he was called upon to study; and to the consequent accuracy and finality of his decisions.

"To have worked with Dr. Deville, as many of us have done, was in itself a liberal education. His own habits of punctuality, of diligence and of industry were certain to impress those under him with the sincerity and conscientiousness of his service. His hours of work were not subject to measurement by the ordinary limitations of attendance registers or time clocks. He was content to 'scorn delights and live laborious days' in order that duty should not only be well done, but perfectly done."

THE JAPANESE EARTHQUAKE, SEPTEMBER 1, 1923

By Ernest A. Hodgson

The greatest earthquake disaster in all history—the Japanese earthquake of September 1, 1923—has now receded far enough into the past that one may examine the data with some regard to their relative value. They may be divided into three groups: those recorded at the time by seismographs and similar instruments, both in Japan and elsewhere; those obtained from the reports of eye-witnesses—persons who experienced the earthquake and fire, and live to tell their story of it; and those which may be deduced from an examination of the destruction to property or of changes in the configuration of the earth on shore and below the sea.

The seismographs at Tokyo were in operation at the time of the earthquake. Dr. Omori, the director, was absent at the time as delegate to the Pan-Pacific Science Congress in Australia. Dr. Imamura was in charge and it was due to his care and to the assistance of his helpers that the records were preserved. The seismometric laboratories at the Central Observatory took fire several times, but being built of reinforced concrete they resisted the earthquake very well and it was found possible to extinguish the flames as fast as they broke out on the roof.

Three instruments, equipped as strong motion pendulums, were in operation. They had little or no magnification and their records are therefore of value. The other seismographs, having high magnification, were not able to record the strong motion. The record ran off the sheet, even on the unmagnified seismographs.

The Tokyo records show that the earthquake began at 11h. 58m. 44s., a.m., Japan time, Sept. 1. They indicate an epicentre 63 miles S.S.W. from Tokyo, near Oshima island. The earth waves moved, in general, N.N.W. They had an amplitude of 18 centimetres, or a little over 7 inches. The period was 2 seconds.

Dr. Imamura estimates that there were over 114 shocks the first day, 88 on the second day, 60 on the third and 47 on the fourth. The important after-shocks are listed as follows:

	Date	Time	Direction	Dist. miles	Ampl. in.
1	Sept. 1	0-40 p.m.		44	1.5
2	Sept. 1	0-48 p.m.		56	1.1
3	Sept. 1	2-32 p.m.	S.S.W.	56	0.8
4	Sept. 2	11-58 a.m.	S. (slightly E.)	76	2.7
5	Sept. 2	2-12 p.m.	S.E.	24	0.6
6	Sept. 2	6-27 p.m.	E.S.E.	51	2.0
7	Sept. 2	10-39 p.m.		100	1.9

The earthquake was registered at seismographic stations all over the world. The record at the Dominion Observatory, Ottawa, was registered on all the instruments—four horizontal seismographs, a vertical seismograph and a slow scale "Deformation Instrument." The records obtained at Saskatoon and Halifax were also read at Ottawa. These records were made on small Mainka, two component, horizontal seismographs with mechanical registration. The machines are mounted at the University of Saskatchewan and Dalhousie University, respectively. The readings from all the records may be tabulated as follows

No. 1573 Ottawa Time: G.C.M.T.

September 1, 1923

Phase	Time h. m. s.	Period s.	Amplitude E.W. microns	Distance kms.
O	2-58-59			9760
eP	3-11-49			
iS	3-22-36			
eL	3-37	(60)		
M	3-53.5	20	381	
L	4-03	17	171	
L	4-30	16	71	
L	4-54	14	37	
L	5-16	14	16	
L	5-48	14	9	
L	6-05	13		
L	6-40	13		
L	7-05			
eL	8-02			
L	8-25	28	15	
L	8-34	19	9	
L	8-50	13		
F	9-50			

	SASKATOON	
O	2-58-35	8520
P	3-10-25	
S	3-20-09	
eL	3-31.5 ca	
	HALIFAX	
O	2-58-55	10050
P	3-12-00	
PR_1	3-15-50	
S	3-23-00	
SR_1?	3-29-18	
eL	3-42-30	

According to Dr. Imamura, the tremor lasted for 13.9 seconds at the Central Observatory, Tokyo. Presumably the shock at the epicentre itself was of shorter duration. When a stone is thrown into a quiet pond the shock is instantaneous but the wave disturbance continues for some time. In making readings at distant seismometric stations it is assumed that the breakdown consists of a single sharp crack. It is also assumed that the earthquake centre is at the surface. Both these assumptions are not strictly justified, but there are at present no well-established allowances for depth of focus, as it is called, and no provision is made in the readings for continued oscillations at the epicentre or origin. When the first tremor is the greatest the after-shocks do not affect the readings appreciably.

At the time of the earthquake three classes of waves radiate out from the epicentre. These are called the *P* or preliminary wave, the *S* or secondary wave and the *L* or long wave. The first two travel through the earth from epicentre to station, dipping somewhat deeper than does the direct chord connecting the two places. The third class travels along the surface.

The *P* wave is due to a longitudinal vibration. It travels at an average rate of about 500 miles a minute. Its velocity is smaller for short distances than for greater ones so that the curve showing the relation between distance and time declines in steepness with respect to the distance abscissa as the distance becomes greater.

The time of arrival of this wave at the station is denoted by *P*. *eP* indicates that it was an "emergent *P*", a difficult offset to determine exactly. Referring to the table of values we note that *P* arrived at Ottawa at 3h. 11m. 49s., G.C.M.T., or 12h. 11m. 49s., p.m., Japan time. It reached Saskatoon sooner, of course, at 3h. 10m. 25s., and Halifax later, at 3h. 12m. 00s.

The *S* wave is due to a transverse vibration. It travels at an average rate of about 275 miles a minute. Its velocity curve is also concave toward the axis of distance, *i.e.*, the wave travels somewhat slower for short distances than for long ones.

This wave arrived at Ottawa at 3h. 22m. 26s., G.C.M.T., or 12h. 22m. 36s., p.m., Japan time. It is denoted by *iS*, indicating that the arrival was in the form of a sharp offset or impetus. The times of arrival at Saskatoon and Halifax are respectively 3h. 20m. 09s. and 3h. 23m. 00s.

From the records of a large number of earthquakes, the time and place of which were accurately known, emperical curves have been drawn showing the rate of propagation of these two classes of waves. Tables have also been made showing the time required for the *P* wave to travel various distances and showing the relation between the difference in time of arrival of the *P* and *S* waves (*S-P*) and the distance from epicentre to station (Δ).

Knowing *S* and *P* for Ottawa's record of the Japanese earthquake we can find *S-P*. Looking up the *S-P vs* Δ table gives us $\Delta = 9760$ km. Then using the table showing the relation between the *P* interval, I_P—the time required for *P* to travel from the epicentre to the station—and Δ we get the value of I_P corresponding to 9760 km. If we subtract this value from the time of *P* at Ottawa we obtain the value of *O*—the time at the origin. Performing this work we find $S\text{-}P = 10$m. 47s.; $\Delta = 9760$ km.; $I_P = 12$m. 50s.; and hence $O = 2$h. 58m. 59s., G.C.M.T., or 11h. 58m. 59s., a.m., Japan time.

If all records were perfect, and if all the recorded times as made by the clock on the record sheet were perfect, the value for *O* should be the same from whatever station the deduction was made. Referring to the table we find that as deduced from the Ottawa, Saskatoon and Halifax records the values for *O* are respectively 2h. 58m. 59s.; 2h. 58m. 35s.; and 2h. 58m. 55s. These

are to be compared with the Tokyo value, given by Dr. Imamura, as 2h. 58m. 44s., G.C.M.T. or 11h. 58m. 44s., a.m., Japan time. The value deduced by Ottawa is 15s. late, that deduced from the Saskatoon record is 9s. too soon, and that obtained from the Halifax record is 11s. too late. The average for the three Canadian stations gives $O = 2$h. 58m. 50s. or 6s. late.

Besides the P wave which reaches the station direct there is a P wave which comes to the surface half-way between the epicentre and station and on being reflected at the surface is relayed on, through the earth, to the seismograph. This wave, known as the PR_1 or first repeat P wave was recorded at Halifax at 3h. 15m. 50s. G.C.M.T. It cannot be distinguished on the records at the other stations.

Besides the S waves which reach the station direct we get those reflected as were the PR waves. The first of these, reaching a station, is denoted by SR_1. This phase reached Halifax at 3h. 29m. 18s.

The L waves travel at what is usually looked upon as a uniform velocity. This is, on the average, about 140 miles a minute. It has been found that this velocity is usually greater if the wave, which is propagated through the earth at the *earth* surface, is forced to pass under a deep ocean. At the usual rate of propagation we would expect the L wave to reach Ottawa at 3h. 41.8m. But it arrived at 3h. 37m., *i.e.*, the velocity is greater than normal. As a good deal of its path was beneath the Pacific Ocean we must assign most of the discrepancy to that source.

The time of arrival of the L wave at Saskatoon is also too soon for normal propagation, but the time of arrival at Halifax is exactly normal. If we trace our great circles connecting Tokyo with the three stations we find that the one between Tokyo and Halifax does not pass through the ocean at all but up through the eastern end of Asia, across Behring strait and down through Canada. Of course this line is to be traced on a globe and not on a flat map. The result is a rather striking instance of the fact that the L waves are affected by the dense ocean bottoms.

If we measure along the great circles from the three stations to Tokyo we find that the value of Δ for Saskatoon brings the epicentre very close to Oshima island. But Ottawa and Halifax,

whose great circles approach the epicentre from a more northerly direction yield values for Δ which fall some 400 miles short of Tokyo in each case. The following possible explanation of this may be given.

An active fault line is known to extend along the edge of the Kurile Deep, parallel to the Japanese coast and in the general direction of Ottawa as measured from Tokyo, along the great circle joining the two places. In all probability the whole fault line was disturbed. The chief shock occurred near Oshima island. The earth waves were propagated from there directly toward Saskatoon. But the waves which left in the direction of Ottawa and Halifax were lost in the general adjustment which traversed the fault line. The records at the two eastern stations then were made by the waves released at the northern end of the disturbed section.

This would account also for the fact that O is late as deduced from the records from these two stations, when compared with the value given out by the Central Observatory, Tokyo. But the clock error, which does not affect the value for Δ does seriously affect the value for O as deduced from the record. The time check at Saskatoon and at Halifax is not as rigorous as is the Ottawa one. The time system of the Dominion Observatory is used for the seismographs there and time, as recorded, is accurate to within a quarter of a second at the most. At Ottawa P and S were fairly well defined, especially S, which was quite sharp. The deduced value for Δ is correct to within about 25 kilometers. The deduced O is correct to within two seconds. Whatever may be said as to the values of O for Saskatoon and Halifax containing a serious clock error and being thereby unqualified to support an argument explaining the difference as above, the fact remains that the Ottawa record gives a value for Δ which certainly falls short of Tokyo and a value for O, which is late by 15 seconds, as compared with the value given by Dr. Imamura.

Examination of the station data shows that the majority of seismographs in Europe and Asia, lying west of the fault line, record O a little earlier than Tokyo as a rule. Hamburg gives 2h. 58m. 26s.; Strasbourg, 2h. 58m. 37s.; Granada, 2h. 58m. 30s. Stations in north-eastern United States and Canada are the only ones lying north of Tokyo and in line with the fault. The records

from these stations do not agree as to *O*. Several records, as given, yield values much too late, one being at 2h. 59m. 16s. and another at 2h. 59m. 39s. As pointed out above, the clock error seriously affects *O* as determined from the seismograms.

Many accounts have been written by those who were in Tokyo or Yokohama at the time of the disaster. One of the first-hand accounts, prepared under very trying circumstances, was the "Earthquake Extra" of the *Japan Times and Mail*, dated—in error—Aug. 4, 1923. This appeared Tuesday, September 4. One can forgive the typographical error as to the date when one reads the account. This edition was hand-set, in an office still rocked by frequent shocks, and the printing was done on a job press, operated by pulling a rope. This issue was distributed gratuitously and boasted the "smallest net paid circulation in the world." It seems only fair to quote it in full.

THE JAPAN TIMES
AND MAIL

EARTHQUAKE EXTRA

Tuesday, Aug. 4, 1923

Tokyo damage—Japan Times estimate:

Honjoku, All burned; Hongoku, All burned; Shitayaku, All burned; Kojimachiku, palace and block south of Hibiya park safe; Imperial hotel and district south safe; Koishikavaku, Edo River side burned; Kyobashiku, All burned; Shibaku, Mostly burned; Azabuku, partly burned. Ushigomeku, safe; Yotsuyaku, Mostly safe; Asakusaku, All burned; Nihonbashiku, All burned; Akasakaku, Half toward city centre burned; Fukagawaku, All burned.

Police estimate at noon that 100,000 were killed in Tokyo.

At the old military clothing department ground in Honjo ward, 10,000 refugees were burned to death Saturday night.

Several thousand perished in the river Sumida.

No further severe quakes will be felt, it is believed. Fire danger is past.

The Emperor has given Y 10,000,000 for relief work.

Kokusai service,—

Anyone refusing to comply with orders under the requisition act will be subject to three years' imprisonment and a Y,3000 fine.

About 600,000 koku of rice were to reach Tokyo this morning. Regular steam service has been established Between Yokohama and Shibaura for goods only.

Navy radio is touch with the outside world.

The Tohoku and Shinyetsu lines are open from Nippori and Tabata. The Joban line is open from Minami Senju. The Chuo line is open between Kameido and Chiba. Tokaido line service is open only between Shinagawa and Kawasaki. Steamship service twice a day is open from Shinagawa to Yokosuka.

Yokohama is destroyed save for outlying districts. The bluff suffered especially. Foreigners in Karuizawa and Miyanoshita are safe but great damage was done. The rumor of a tidal wavė at Kamakura seems unfounded. An oil tank at Yokosuka exploded with tremendous devastation. Izusan, Yugawara and Atami are damaged.

The quake centred around Oshima island.

Notables killed: Princess Yamashina, Princess Hiroko Kanin, Princess Dowager Kacho, Prince Nashimoto, Prince Matsukata, Mr. Tokutemi—reported dead, Ex, Minister Matsuoka, Baron K. Sonoda, Fleet Admiral T. Kataoka and wife, the Siamese minister to Japan.

The American consul general in Yokohama is dead.

The most widely circulated and one of the most detailed and accurate accounts of personal experiences is the report of Captain S. Robinson, R.N.R., Commander of the Canadian Pacific S.S. *Empress of Australia*. Captain Robinson's ship was about to leave the wharf at Yokohama, en route to Vancouver. The tugboats had made fast their lines and all was in readiness to cast off when the earthquake occurred. The shock was so great that it seemed as though the masts and funnels would be carried away. The shore presented a terrifying picture, the land "rolling in waves apparently 6 to 8 feet high, like a succession of fast moving ocean swells."

The severe shocks lasted a couple of minutes. Then it was seen that a section, 400 yards long, of the concrete wharf had sunk below the level of the ocean, leaving only the railing visible. Those of the throng who had come down to wave good-bye to departing

friends, and who had not been killed in the opening and closing fissures of the wharf, were seen clambering and wading through the water on top of the submerged pier, toward the shore. These opening and closing fissures were wide. In one case a motor car and its occupants, ready to drive off the wharf, disappeared entirely.

On looking toward the shore, great clouds of dust were seen, completely obscuring the city. . . . And then the fire broke out. Captain Robinson's story of the subsequent manœuvring to get away from the burning freight sheds is a thrilling narrative. It is an extremely difficult task to get a giant ship out of the harbour, with one screw jammed by fouling an anchor cable, with a sixty-mile gale blowing, and with no tugs at hand. For the tugs had cast off and run for safety as soon as the earthquake happened.

Then the next day, after the wind had fallen, a second danger appeared. Bursting gasoline and oil tanks had flooded the waters of the harbour with an inflammable coating. This took fire and a wall of flame, several hundred feet high, sweeping over the surface, made it necessary to again shift anchorage. They were aided this time by the steamer *Iris*. This ship, although only a single screw vessel, and loaded with 2,000 tons of benzine and 2,000 tons of kerosene, generously helped in getting the bow of the *Empress of Australia* into such a position that her captain could steam to safety.

The French steamer, *André Lebon*, filled with Russian and French refugees, had sent her engines to be repaired on shore before the earthquake. The ship was directly in line of the on-coming flames. The captain noted that one section was ahead of the others. This would pass him first and astern of the vessel. Waiting until it had passed, he had a line run out, by means of a motor boat, to a buoy in the burned area and hove the ship astern just in time to let the second patch of flame pass over the spot he had lately occupied.

Captain Robinson's report goes on to tell of the rescuing of refugees and the attempts made to get divers to free the port propeller and enable him to bring the vessel into port at Kobe. His account is published in a little booklet of 24 pages by the

Canadian Pacific Steamship Company and is one of the most valuable documents dealing with the earthquake.

After reading over the many stories of personal experiences, written by those who survived the earthquake, one is at a loss to know the best way to combine and condense the information that none of the more striking details be left out. It has seemed most convenient to bring together these outstanding facts in the form of a series of impressions, without special order or arrangement, obtained by reading the accounts. All minor details and explanations are omitted. In this way the whole may be brought within the space which can be devoted to it.

So after a course of reading, one remembers on reflection:—the great catastrophe at the military clothing depot in Honjo ward, Tokyo; Here 34,000 refugees were cremated alive by the circle of flame which closed in upon them;—the court house at Yokohama which collapsed, killing instantly Judge Suyenaga, the president of the court, 47 judges and the lawyers, clerks and others in attendance;—the rafts floating down the river, crowded with refugees who were killed by others jumping down upon them from the bridges passed;—the combined statistics showing 528,154 houses destroyed and 102,882 lives lost, printed with the comment, "It seems safe to say that if there be anything to add to these figures, there will certainly be nothing to deduct from them";—the 1,319 shocks felt between September 1 and September 17 at Tokyo, which put fresh fear into the hearts of the people in spite of the assurances that it was all over;—the graphic description by a Japanese reporter of a chimney that "fell through the roof and ceiling into the parlour, striking the keyboard of the piano as it had never been struck before";—the earthquake history of Tokyo which includes the fact that in 1703 the city was destroyed and 200,000 people killed;—that fire broke out in three places in Tokyo within 16 seconds of the first shock and that while the crews of the fire apparatus struggled to reach these, 52 other alarms were rung in. The stoic and heroic members of the fire companies located and recorded the alarms by districts and by wards, although they were not able to respond;—the sixty-mile gale that fanned the flames;—the reporter's description of a burning church which stood "like a writhing giant enveloped in blazing cardinal's robes";

—the changes in wind direction which cut off the refugees from their prospective havens;—"Jamming was a hundred-fold worse in narrower streets, where the pressed mass of humanity could only undulate, making three steps forward and almost as many backward, many people with their feet actually in the air";—the terrible holocaust in Honjo ward, Tokyo;—the "pillar of fire", fire whirlwind or fire-spout, which observers on the safe lookout of a high table land could see sweeping over the burning district in Tokyo. This, passing over one man, picked him up, carried him out over a canal and dropped him, the man surviving the experience;—the lady from some wealthy home, dressed in what had once been beautiful clothes, who lowered herself into the canal by a rope and dipped herself under the water as the flames reached out after her, alternating the arm that held to the rope in order to relieve the burns from the flames and falling cinders, by dipping the released arm under water;—the canals full of struggling men who had ceased to struggle as the flames closed in and raised the water to the boiling point;—the "Honjo Horror";—the abbot of Hanzobo temple, an aged priest, noted for his scholarship and high virtues who sat on the dais before the Buddha's image, praying above the din, "Oh lord, if thou wouldst not grant my prayer, it must be because I am not holy enough. Let me die to atone for my failure to save my good neighbours from thy wrath." The record adds, "The Buddha granted his last appeal";—The temple of Kwannon Sama of Asakusa, the god of mercy, which escaped the flames although surrounded by them on all sides. This was due, it is said, to innumerable little rills of water which flowed over it as the heat increased;—the rich merchant who trudged in rags with his family and was such a pitiable sight that the poor people were moved to give him small sums of money. He took the gifts, "not caring to offend or shame the kind-hearted people by refusing." He collected Y,4 in this way, paid Y,100 to a boatman to pilot himself and family to a place of safety and remarks that he is "out Y,96, but that is very cheap as the price of six lives";—the horses and people in a submerged section of a park in Yokohama, "so closely packed that they could not change posture";—the foreman of the mill at Kawasaki who committed suicide because so many under his charge had been killed by the collapse

of the building;—the man caught by the landslide at Yokosuka and buried with just his head above the ground. He was fed with whisky and other things in order to keep up his strength until he could be dug out next day, but when they did get him out he collapsed and died as he was being carried away;—that Odawara was a scene of much worse earthquake visitation than either Yokohama or Tokyo, while of the last two named, Yokohama suffered the worse shake-up;—the tidal waves at towns at the head of Sagami Bay;—the military clothing area in Honjo ward, Tokyo, with its 34,000 deaths by fire;—the naval radio used, as soon as the quake was experienced, to call in warships for supplies and the maintaining of order, all other means of communication being destroyed;—the sincere gratitude of the Japanese people for the ready aid from other countries;—that within less than 10 days the stricken area under martial law was occupied by 21 regiments of infantry, 6 regiments of cavalry, 7 regiments of artillery, 18 battalions of engineers, and other technical and medical corps;—people on the outskirts of Tokyo, standing on the street corners after the earthquake and before the fire, calmly waiting for the power to come on and the next car to arrive;—"and all in the light of noon. Henceforth, the weird and witching hour of unseen dread for me is not midnight, but noon";—the absolute stoicism of the Japanese people whole families sitting stolidly in the yards of their wrecked homes, their worldly treasures gone, their world changed over night, but the father and mother saying little or nothing and the children arranged in a row like small images;—the fleeing refugees streaming out of the city, all day Sunday and all day Monday, many with small handcarts containing all their worldly store, pulled by the father, pushed by the mother, the children walking beside with perhaps a round-cheeked baby or a diminutive and parchment-faced old grandmother perched on top of the load;—and then the stay of the fire for lack of more to burn, the slow cooling of twenty-one square miles of burned territory in Tokyo and suburbs, the return to rescue, the horrid sounds or sights or odours, depending upon the condition of the ones to be rescued;—but one could go on and on and on, and still the story of horror and pathos and grim humour and torture and agony and loss would not have been completed.

In a list such as has just been given it was necessary that the *Honjo Holocaust* should have been repeated. Every description of the earthquake and fire in Tokyo includes this story. The military clothing depot in Honjo ward was a large open area seemingly free from fire menace. The grandfathers of Japan always tell their grandchildren that in times of an earthquake they are to go to an open space where there are trees. It is a tradition in the country. So the rich, the poor, the old, the young, men, women and children, some with food, some all unprepared, came from near and far, flocking into the open space of some twenty acres. They came, bringing their treasures on their backs. Each little group had its pile of clothing and inflammable *bric-a-brac*. Some, who lived near, made repeated trips to their wrecked homes for household effects. Soon the field was filled with a crowd of 34,000 people. They were now quite closely placed. The packs of goods had been thoroughly distributed among them. These were about as inflammable as excelsior. Then the fires jumped the Sumida river in two places and began burning in Honjo ward. Hour after hour the ring of fire closed in. No one could leave. The houses near began to burn. Frantic cries for help arose from a people hitherto quiet and methodical. The sun went down, a red ball in the smoky flames. The light was still as bright as day but a fearful red. The burning embers were carried over the field by a sudden burst of wind and simultaneously the bundles all over the place began to burn. The din of shrieks grew louder, reached a fearful pitch, and then almost at the same time over the whole crowd a pall of silence fell. One more paragraph, quoted in full from the *Japan Times*, will complete the story.

"Still another survivor says that, in the part of the ground where he was rescued afterward, the cry for help and prayers ceased after the cyclone-carried embers had set the goods heaps on fire, the multitude becoming apparently too weak to emit articulate words, but all arose to their feet about three times, at brief intervals, as if in utter agony and each time gave vent with one accord to the most mournful, but soul-piercing groan ever heard on the earth. They did not rise for the fourth time—all things human there had gone to eternal silence. Out of 34,000 only a few hundred escaped death by nothing short of miracles."

Small wonder that in enumerating the outstanding episodes of the tragedy one seems called on to mention repeatedly this terrible story.

How could any escape? A rich banker took his family in his automobile and started for the clothing depot as the flames grew worse in his section of the city and there seemed to be safety there. As they went, a cyclone or whirl-wind took up the banker's youngest son, whirled him away and dropped him in a muddy ditch. The son was saved but Mr. and Mrs. Yoshida perished in the crowd.

And now that the fire is over, the dead buried, the saved remnants of families sorted out once more, the debris cleared up and the memories of the fearful experiences softened somewhat by time, the Japanese are turning their attention to the rebuilding of their city. The ground was badly split up into cracks but that is as nothing compared to what the hydrographic surveys of Sagami bay and Tokyo bay have discovered. Ridges 180 to 300 feet high appeared in some places. In one area the bottom, formerly 3,000 feet below the surface, rose 1,200 feet, making a new depth sounding only 1,800 feet. At another position two miles from that point the bottom of the sea near the shore sunk 600 feet. It was this extreme vertical motion which produced the landslides experienced near Yokosuka.

The buildings which survived the earthquake are those made of reinforced concrete. But where the concrete used was massive with respect to the steel reinforcing beams the construction was broken. The lessons learned may be briefly outlined. The workmanship must be first class in the first place. The walls and framework must be made more massive and sturdy near the ground and lighter above. The inner walls must be made strong enough to move the weight above them in case of an earthquake. Rigid steel braces must be used to bind the whole building into a single unit. Filler walls of terra-cotta and brick, filling in spaces in the ferro-concrete framework are to be avoided. Roof tiles are to be very carefully secured in place. Floors and roofs are to be made as light as possible. The buildings should not be too high, sky-scrapers are no use in an earthquake region.

Considering the past earthquake history of Tokyo, its present state of almost total destruction, and the certainty that another

earthquake will happen there sooner or later, makes one question whether the advantages of an almost perfect harbour can make up for the losses likely to be experienced if the city is reared again on the old site. But home ties are strong and the lesson is not likely to be learned. The "New Tokyo" is being built. Let us hope that the buildings will be fire proof as far as possible and that plenty of open space will be left, planted freely with trees, and laid out as parks, which may prove a safe refuge when the earthquake next visits this island Empire.

Dominion Observatory,
Ottawa, Canada.
October 25, 1924.

FOCUS OF AURORAL STREAMERS, SEPTEMBER 23, 1924

By T. R. Rosebrugh

On the evening of the 23rd of September last I had an opportunity to see at Go Home, Ontario, the very remarkable Aurora of that date.

After the development of the usual crown formation in the north there appeared about ten o'clock a waving curtain of light in the east, the lower hem of which appeared brightly coloured. This advanced towards the west and about 10.30 part of it was nearly overhead. The closer portions of this lower edge were now discontinuous, in other words, it was broken up into many distinct shafts of light which rapidly changed position or disappeared.

The perspective effect of parallelism was so pronounced that it was clear that the star Eta Pegasi was very close to the vanishing point or radiant of the group at 10.36 p.m. Eastern Standard time.

Prof. L. B. Stewart has kindly determined the position of this star as seen from Go Home at Lat. 45° 00′ and Long. 79° 56′W. to be Altitude 74° 37′, Azimuth 10° 11′ east of south.

Mr. John Patterson of the Meteorological Office has also kindly supplied me with magnetic values taken at the Agincourt station within a few minutes of the time mentioned and which were varying rapidly.

By interpolating between these values, however, and correcting for the difference in position (Agincourt and Go Home) by L. A. Bauer's magnetic tables, I find the magnetic zenith at Go Home to have at 10.36 p.m., Altitude 75° 30′, Azimuth 7° 48′ east of south. At this high angle the difference in the azimuths 2° 23′ would correspond only to about 36′ of arc. Thus the "magnetic zenith" was 53′ north and 36′ westward of, the perspective vanishing point of the aurora as measured by arcs on the celestial sphere, or within about one degree of it.

By trigonometrical formula the distance between the estimated focus and the magnetic zenith is found to be 1° 5′.

How accurate an observation of this kind might be is, of course, a question. I should suppose that as some of the streamers came pretty close to the star in question the error would not be more than a degree of arc.

BOOK REVIEW

A Handbook of Solar Eclipses. By Isabel M. Lewis. XI +118 pp. Duffield & Co., New York. Price $1.25.

This small volume, written especially for the coming eclipse of January 24, 1925, contains in addition considerable information about eclipses in general.

The book is divided into twenty-two short chapters, but may roughly be treated in two parts. The first part deals with the geometry of eclipses, their theory and prediction. No mathematics enters into the book and yet the nature of the problem is clearly set forth. The author shows herself thoroughly at home in this branch of the subject and we have never seen a clearer exposition of the manner in which eclipses reoccur in a saros and the way one saros will differ from the preceding and the one following. In Chapter VII are brought together the various things which enter into an eclipse prediction, the shape and size of the earth, the distances to the moon and sun and their apparent motions, all of which must be very accurately known to be able to compute the path which the shadow of the moon will take across the surface of the earth. These predictions have been made for more than a century with great exactness and have never been known to fail. The flat earth theorist is given something to think about, if indeed he can think, and the author suggests that such people attempt to predict an eclipse assuming the earth to be flat.

The second part of the work is devoted to the observations of eclipses, more especially those that have crossed, or will cross, the United States and particular attention is given to the coming eclipse of January, 1925. The general phenomena preceding an eclipse are interestingly described and several things that the amateur may do are emphasized—such as, watching for the occurrence of the shadow bands, noting if the eclipse is really total or not, drawing the shape and extent of the corona.

This part of the book does not pretend to be complete, but it is calculated to arouse the enthusiasm of the amateur that he may do something worth while. The author has succeeded in writing an inspiring book. To the veteran eclipse observer it will make a pleasant evening's reading. The amateur will learn considerable of the methods used in observing eclipses and something of the importance and meaning of the subject.

R. K. Young.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Query

Would you be good enough to give me your opinion regarding the following statement about the rainbow?

I am claiming that no two persons can see exactly the same rainbow. I have been arguing with quite a number on this point, but have not met with anyone who can see this or will believe it is a fact.

I might just say how I noticed that there is a different rainbow for every one. I was walking up my lane and was going east and a rainbow was visible at the time. It was between myself and a long hill. When I came to the turn in the lane I travelled south and, of course, the rainbow travelled along the hill, keeping pace with me. When I stopped, it stopped; when I started again, it started. In that case, had a person been with me walking east and had stood at the turn while I went south, his rainbow would not have moved.

Might I ask also for the names of any books on astronomy and where I may secure the same?—F. M. P.

Answer

The argument regarding the rainbow is perfectly valid. The location of the rainbow is determined by the position of the observer relative to the sun. A line from the sun passing through the observer always passes through the centre of the circle of which the bow is a part. Consequently there is a rainbow for each different position a person may be in.

As to books on astronomy for the general reader, I would suggest the following:

1. *Starland*, by Sir Robert Ball.
2. *The Story of the Heavens*, by Sir Robert Ball.
3. *Astronomy*, by Sir Frank Dyson.
4. *A Beginner's Star Book*, by Kelvin McKready.
5. Hutchinson's *Splendour of the Heavens*.

No. 1 is a series of lectures to children, but even the adults will enjoy them. No. 2 is charmingly written and well illustrated. Both of the above works were published thirty or more years ago, but they have not yet grown old. No. 3 is a small book but it gives a comprehensive outline of the subject. No. 4 is specially

for the observing amateur. It is beautifully illustrated and is very attractive and practical. No. 5 has recently been completed. It is in two handsome volumes, containing about 1000 pages and over 1000 illustrations. The cost is 42 shillings for the two volumes, but, considering the style of the work and the wonderful pictures, the price is low. If I should offer a criticism of the work it would be that it contains almost too much material. It is somewhat encyclopedic in nature and the chapters are by different people. Such a book as this placed on the living-room table, always easy to look into, should prove a treasure-house for young and old to draw from. He is a strange person who will not be full of wonder and admiration at the numerous remarkable illustrations of the beautiful and mysterious objects in the sky.

Astronomical and Civil Time

In the "History of the Royal Astronomical Society 1820-1920" are the following paragraphs (pages 225-226):

Nearly at the end of the first century of its existence the Council was called upon to give an opinion on a subject of great importance, the commencement of the astronomical day. It was not the first time that this question had been laid before them. Since the days of Ptolemy astronomers had counted their day from noon, without the rest of the world being aware that here was an intolerable grievance which ought to be redressed. But at the Washington Prime Meridian Conference in 1884 it was resolved, among other things, "almost without debate, certainly without adequate consideration", says Newcomb, that the astronomical day ought to begin at midnight like the civil one. This resolution, however, met with little support outside the Conference. In a paper printed in the *Monthly Notices* in the following January, Newcomb expressed himself very strongly against the proposed change, chiefly on account of the discontinuity it would introduce into astronomical tables and ephemerides, and at the Geneva meeting of the *Astronomische Gesellschaft* in 1885 August he did the same. As he was Editor of the American Ephemeris his vote was of great practical importance, apart from the weight any utterance of his would naturally carry. Of prominent Continental astronomers, Otto Struve and Oppolzer seem to have been the only ones in favour of the proposed change.

The matter came before the Council of our Society in 1885 June, when a letter from the Science and Art Department was read, stating that the Committee of Council on Education had asked a Committee (including Adams, Christie and Hind) to advise them. In accordance with the recommendations

of this Committee a copy of the resolutions of the Washington Conference was now forwarded, "which My Lords consider to commend themselves for adoption". It was resolved on the motion of Christie that the Council of the R.A.S. concurred in those resolutions, and proposed that the change be adopted in the *Nautical Almanac* for 1890.

But the opposition had been too strong, and it was probably realized that no other ephemeris would follow the example of the *Nautical Almanac*. The matter was therefore dropped and nothing more was heard of it for many years.

In 1917 attention was again drawn to the fact that the system hitherto in use was by many sailors found to be a fruitful source of error, and in 1918 January the Admiralty addressed a letter to the Society, requesting them to ascertain the views of astronomers about changing the commencement of the astronomical day. A Committee was appointed and reported in the following November. Of seventeen replies received to a circular, nine were decidedly in favour of the change, three decidedly against it, five not very decided. A specially important favourable reply had been received from the American Astronomical Society, who had consulted four observatories and eighteen individuals; the result was three votes to one in favour of the change. The Committee recommended the change to be made in the *Nautical Almanac* from 1925, and their Report was adopted by the Council. The Admiralty have accepted this decision, and as the *Connaisance des Temps* and the *American Ephemeris* will make the change from the same date, astronomers are now committed to this innovation, for better for worse.

In connection with this historical statement it might be added that in April 1893 a circular was sent out to astronomers of all countries by a Joint Committee of the Canadian Institute and the Astronomical and Physical Society of Toronto (now the R.A.S.C.) dealing with the question of the unification of time. This action had been brought about largely through the leadership of Sir Sandford Fleming, who was chairman of the Committee. The circular quoted at some length the opinions of astronomers on the subject and it requested a statement of opinion from the one to whom it was sent. The replies were summarized next year and it was found that out of 171 replies, 108 were favourable to the proposed change and 63 opposed. Of the 22 countries represented, 18 were favourable and 4 opposed. The matter was brought before the Geographical section of the British Association at the Toronto Meeting in 1897 by G. E. Lumsden and a portion of his paper is printed in the Transactions of the A. & P. Society for 1897 (page 61). It contains a clear presentation of the case for the proposed unification, especial consideration being given to the needs of the mariner.

Appointments at Mount Hamilton and Victoria

Following the relinquishing by Dr. R. K. Young of his position in the Dominion Astrophysical Observatory at Victoria to become Associate Professor of Astronomy in the University of Toronto, Mr. J. A. Pearce has been appointed Astronomer at Victoria. Mr. Pearce during the last two years has been Fellow at the Lick Observatory and for the two years before that he was Demonstrator in Astronomy in the University of Toronto. Mr. Harold F. Balmer, who was Demonstrator in Astronomy at the University of Toronto for the last year has been appointed Assistant in the Lick Observatory, his duties beginning on October 1. C. A. C.

MEETINGS OF THE SOCIETY

At Toronto

October 14, 1924.—The first regular meeting of the Society for the autumn term was held in the Physics Building of the University at 8 p.m., the 2nd Vice-President, Mr. A. F. Hunter, in the chair.

The Chairman read a letter of thanks from a committee of the House of Assembly, Bermuda, for enocuragement of their project of establishing an observatory in Bermuda.

The following were elected Members of the Society:

Edwin F. Carpenter, M.A., Lick Observatory, Mount Hamilton, Cal.

W. J. Kerr, Wellington, New Zealand.

Rev. G. W. Ball, Liverpool, N.S.

Robert G. Lough, 818 Boulevard N.W., Calgary, Alta.

Rev. D. P. McMenamin, P.P., Massey, Ont.

Hugo Benioff, B.A., Lick Observatory, Mount Hamilton, Cal.

Nelson S. Lougheed, Port Haney, B.C.

Mrs. H. L. Hutt, Georgetown, Ont.

John Dibblee, B.A.Sc., H.E.P.C., University Ave., Toronto.

Observations during the past summer was the topic for discussion at this meeting, and W. E. W. Jackson, M.A., of the Observatory opened the subject with a carefully prepared account of the sun spots, solar activity and magnetic activity from the beginning of the year. William Gore described the aurora of September 23 as he witnessed it at Port Elgin. Prof. C. A. Chant also gave a description of the same aurora, and described a lunar halo which he had observed on the evening of September 11.

Mr. A. F. Miller urged that steps be taken as a Society to observe the coming total eclipse of the sun on January 24, 1925. He also described his observations on the aurora of September 23, and the planets Mercury, Venus, Saturn, Jupiter and Mars.

Mr. F. T. Stanford spoke of some recent noteworthy observations, as noticed in the magazines, viz., the comets due to appear this year, Marconi's discovery that wireless waves vary in their courses around the earth according to the time of day or night, and other phenomena and propositions. Dr. J. B. Fraser had noticed the frequency with which meteorites travel parallel with the surface of the earth. Several other members also contributed to the discussions.

October 28.—A regular meeting of the Society was held, the 2nd Vice-President, Mr. A. F. Hunter, in the chair.

The paper of the evening, contributed by the Vice-President, Mr. A. F. Hunter, on "The New (Bombardment) Theory of the Aurora", emphasized the construction of the Crookes Tube as the beginning of a new era in physical

science. The discovery of electrons, resulting from it, was soon followed by the suggestion, made first by Prof. A. Paulsen, a Danish investigator, that the aurora could be explained as the action of electron projectiles, directly or indirectly having the sun as their source. Examples of vacuum tubes were used to illustrate the influence of electrified and magnetized bodies upon the courses of streams of electrons. The high vacuum of the Crookes Tube imitates the condition of outer space beyond the earth's atmosphere, where the aurora occurs. The earth's magnetism draws the flying electrons towards the polar regions, and their bombardment of thinly distributed particles and upper clouds at the top of the atmosphere produces the light from the aurora. Upright streamers result from repulsion of the electrons by the high charge of electricity at the top of the atmosphere. The paper concluded with details of the transient markings on the planets Venus and Mercury, apparently the work of greater auroral action at those planets by reason of their proximity to the sun. Lantern slides and apparatus were used to illustrate the lecture.

Mr. Hunter's paper was illustrated by a number of experiments. The thanks of the members were tendered to Dr. Gilchrist for the trouble he had taken in setting up the apparatus.

November 11.—A regular meeting of the Society was held, the Vice-President, Mr. A. F. Hunter, in the chair.

The following were elected members of the Society:

S. Sowden, 104 Moore Ave., Moore Park, Toronto.

H. G. Hanley, Burwash Hall, Victoria College, Toronto.

The first paper of the evening was given by Mr. A. F. Miller on "Some Results of Observations of Mars during the 1924 Opposition." Mr. Miller described a series of observations he had been able to make with his own telescope, a 4 in. Wray, equatorially mounted and driven by clockwork. Most of the general features and prominent markings presented towards the earth, were well seen by him, but he thought that some of the fainter markings had been better seen on the occasions of former oppositions. Maps of the planet's surface with details of many of the markings were shown and described. Details of the observations will, it is hoped, appear in the JOURNAL in the near future.

A second paper by Dr. A. D. Watson was presented dealing with "Proposed Calendar Changes." Dr. Watson spoke of the development of the calendar until it had arrived at the form in which we have it at the present time, and described a number of attempts that have been made to still further improve it. The fractional part of the day at the end of the year and the slow shifting of the equinoctial points were the chief difficulties to overcome in the arrangement of any satisfactory calendar. These, he thought, were very well met in suggestions he had made in a paper presented before the Society on September 29, 1896, wherein it was proposed to have a calendar having 13 months in the year, 28 days in each month, and one day not included in any of the months but called New Year's Day, with an extra day once in four years, with a distinctive name for leap year.

AT MONTREAL

A meeting of the R.A.S.C., Montreal Centre, was held in the Macdonald Physics Building on Thursday, February 28th, 1924. In the absence of the President the chair was taken by Dr. A. S. Eve.

Five new members were elected, namely: Messrs. D. G. McElwain, R. M. Briggs, Francis Kurie, E. Russell Paterson, R. B. Ross.

The address was given by the Hon. Pres. Mgr., C. P. Choquette, on the subject, "The Moon Has No Atmosphere—Why?"

The speaker dealt in a charming manner with the phenomenon of "counter-glow", "lueur anti-solaire" or "gegenschein", as the faint glow is called which is seen directly on the sky diametrically opposite to the sun, due probably to the repulsion by radiation pressure on light gaseous particles rather than to an accumulation of particles at a neutral point where the gravitational forces vanish.

To this same cause radiation pressure, the absence of atmosphere on Mercury, the moon and other satellites was attributed by the speaker.

March 28.—The Vice-President, Professor Gillson, occupied the chair.

An address was given by the Assistant Recorder, A. V. Douglas, on "The Riddle of the Stars". The following subjects were briefly discussed: The nature of light and its origin within the atom; the emission and absorption lines of the spectrum and their interpretation as giving information about the constituent elements of the star, its temperature, pressure, intrinsic luminosity, and hence its parallax; its single, double or multiple nature, and its radial velocity. Rigel, Polaris and Betelgeuse were taken as typical of three giant stars of different types representing various stages of stellar evolution. The question of stellar energy and the synthesis of elements was discussed, also the emission of calcium and sodium gas from giant and dwarf stars, and the close spectral connection between certain nebulae and the hot giant stars with which they are associated. Silberstein's interpretation of Doppler displacement as in part due to the distance of the star was referred to. In conclusion stress was laid upon the value of speculative theories about the unsolved stellar problems as often paving the way for an advance of definite knowledge.

After comments by Dr. Eve upon the Rutherford-Silberstein controversy over the theoretical synthesis of helium, and by Professor Gillson on the complexity of the problem of mutual forces between the component stars of a multiple system, a vote of thanks was passed and the meeting adjourned.

April 24.—The President, Mr. Justice Howard, occupied the chair.

Dr. Bell Dawson, F.R.S., Director of the Tidal Survey of Canada, gave an address on "The Influence of the Sun and Moon on the Ocean."

The solar effects are twofold:

(1) Heat producing both expansion and greater evaporation, thus causing currents and oceanic circulation.

(2) Attraction giving rise to tides.

These solar tides are much less in magnitude than the lunar tides due to the much greater distance of the sun, and are evident only as they augment or diminish the lunar tide according to the relative positions of sun and moon.

The magnitude of tide in its relation to the phases of the moon was observed in very early times, Alexander the Great, Julius Caesar and Pliny, referring to naval manœuvres, indicate their knowledge of the direct connection between these two phenomena; but not until the mind of Newton turned upon this problem was the explanation found to lie in the universal ty of the law of gravitational attraction.

The character of a tide is determined by three things:—

(1) The phases of sun and moon, producing Spring (or high) tide and Neap (Saxon word for low) tide.

(2) The distance of the moon, varying as it does from perigee to apogee. Since the tide producing force varies as $1/r^3$, a 15% to 18% increase in height may result at perigee.

Spring tide	Perigee	27.1 ft.
	Apogee	20.4 "
	Mean	23.7 "
Neap tide	Mean	17.4 "

Thus there may be greater difference between the extremes of a Spring tide than between average Spring and average Neap tide.

(3) The inclination of the Moon's orbit to the plane of the equator, resulting in diurnal inequality of the two tides. If the moon be on the equator the two tidal levels are the same on the same circle of latitude, but when the moon is north or south of the equator, the tides are oblique to the earth's axis and thus a high and a low maximum tide is obtained each day—the greatest variations in height are attributable to this cause.

Every known type of tide is found on the Canadian coasts, the dominating influence in various localities being any one of the three causes above mentioned. Thus cause 1 is the controlling influence at Halifax; cause 2 in the Bay of Fundy and Hudson Strait (35 ft. range); cause 3 in Northumberland Strait.

The difference in the quarters of the lunar month are due: (1) To the faster motion of the moon at perigee, and (2) to the motion north and south of the equator.

Many tidal peculiarities are due to coastal configurations such as:

(*a*) An estuary open at one end to ocean; currents are regular.

(*b*) A strait—example, Strait of Canso, has its two openings into basins of different types of tides, hence complexity of currents. Similarly on B.C. coast currents are in some places so violent that large vessels have to wait for the time of slack water.

(*c*) Large enclosed area with only a small entrance—example, Cape Breton lakes with 6 inch tidal range inside and 5 ft. range outside, hence water pours in and out with turbulent current and the only slack water is at time of half tide level. To an even greater extent in certain B.C. lumbering inlets where there is an 18 ft. tide outside and thus a 9 ft. head in and out producing violent currents.

The tidal lag of about one and a half days due to frictional retardation was explained; and in conclusion attention was drawn to the various problems arising from the tides in connection with navigation, dock construction, fishing

(always better on a rising tide) and the methods of observing and recording tidal levels and other necessary data.

A vote of thanks was tendered the speaker by Dr. L. Silberstein, who expatiated upon the beauty of the subject. The chairman added some interesting remarks on the fallacy of the idea that the orientation of the crescent moon indicated the weather.

November 21.—*Annual Meeting.* President, Mr. Justice E. E. Howard, in the chair.

Resolutions of sympathy were passed on the motion of Dr. A. S. Eve to be sent to Mrs. A. W. Strong, widow of the late Secretary-Treasurer of the Society, whose services were freely and efficiently given for many years and whose loss is deeply felt; and to Mrs. Ridgewell, mother of the late Ernest Ridgewell, whose sad death due to a drowning accident has robbed the Society of an enthusiastic member.

On motion it was carried that the offices of Secretary-Treasurer and of Recorder be altered to those of Treasurer and Secretary, the latter to include both corresponding and recording duties.

New members were elected as follows:

Dr. J. B. Porter, Dr. E. S. Bieler, Dr. J. B. McConnell, Miss M. C. Edwards, Miss Jane Howard, Messrs. R. C. Ruark, A. R. Tourgis, LeSueur Brodie, J. M. Young, T. N. White.

The annual election of officers resulted in the following:

Honorary President, Mgr. C. P. Choquette.

President, Mr. Justice E. E. Howard.

First Vice-President, Dr. A. S. Eve, F.R.S.

Second Vice-President, Prof. A. H. S. Gillson.

Treasurer, Prof. A. J. Kelly.

Secretary, A. Vibert Douglas.

Council—H. E. Asbury, J. L. Clarke, W. E. Lyman, Geo. Sample, Julien C. Smith.

Announcements were made by Dr. Eve regarding proposed lectures for the next few meetings, and regarding the possibility of getting up a special party to go to Hamilton on January 24th in order to see the total Solar Eclipse.

The meeting was preceded by a joint gathering of this Society with the McGill Physical Society and Sigma Xi, at which Dr. R. K. Young, Professor of Astronomy at the University of Toronto, gave an interesting lecture on "Making Discoveries in Astronomy."

The lecturer outlined the routine work of a large observatory and then discussed the principles underlying the spectroscope, explaining how a spectrograph gives information regarding the constitution of a star, its temperature, velocity and distance. Slides were shown illustrating these points and showing the telescopic arrangement at the D.A.O., Victoria, B.C.

A hearty vote of thanks was moved by Dr. D. A. Murray and carried unanimously.

A. VIBERT DOUGLAS,
Secretary.

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